ORIGINAL

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
	DOCKET FILE COPY ORIGINAL	
Amendment of the Commission's Rules	)	ET 97-99
to Relocate the Digital Electronic Message	)	
Service from the 18 GHz Band to the	)	
24 GHz Band and to Allocate the	)	
24 GHz Band For Fixed Service	)	

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JUL 23 1997

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

To: The Commission

REPLY OF WINSTAR COMMUNICATIONS, INC. TO JOINT OPPOSITION TO PETITIONS FOR RECONSIDERATION, PARTIAL RECONSIDERATION AND CLARIFICATION

Pursuant to Section 1.429(g) of the Rules and Regulations of the Federal Communications Commission ("FCC" or "Commission"),[1] WinStar Communications, Inc. ("WinStar") hereby submits this Reply to the Joint Opposition to Petitions for Reconsideration, Partial Reconsideration and Clarification (the "Joint Opposition") filed by Digital Services Corporation, Microwave Services, Inc. and Teligent, L.L.C. (collectively "Teligent") in the above-captioned proceeding.[2] The Commission will recall that WinStar filed a Petition for Clarification in this matter on June 5, 1997.[3] By this Reply, WinStar simply wishes to (1) clarify that it has standing in this matter,

[1] 47 C.F.R. § 1.429(g) (1996),

[2] *Order*, ET Docket No. 97-99, 62 Fed. Reg. 24576 (May 6, 1997) ("DEMS Relocation Order"). The Reply to Opposition deadline in this matter was extended to July 23, 1997 pursuant to *Order*, ET Docket No. 97-99, DA 97-1517 (released July 17, 1997).

[3] A number of other parties filed Petitions of Reconsideration or Partial Reconsideration of the DEMS Relocation Order including WebCel Communications, the Millimeter Wave Carrier Association, BellSouth Corporation, and DirecTV Enterprises, Inc. These parties and WinStar are collectively referred to herein as the "Petitioners."

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notwithstanding the assertions of Teligent, (2) note that the material concerns raised in WinStar's Petition for Clarification were not addressed by Teligent, and (3) provide the Commission with an independent engineering report that calls into question the propriety and technical underpinnings of the fourfold increase in spectrum now available at 24 GHz to DEMS licensees formerly authorized in the 18 GHz band.

Finally and as touched on in footnote 3 above, WinStar notes that a number of other parties have filed Petitions for Reconsideration and Partial Reconsideration of the DEMS Relocation Order. By this pleading, WinStar reaffirms that it only seeks action on its Petition for Clarification and the instant Reply to Opposition in the event that these Petitions for Reconsideration and Partial Reconsideration are substantially denied by the Commission.[4]

I. *SUNCOM* IS ENTIRELY INAPPLICABLE TO THE QUESTION OF WHETHER THE PETITIONERS HAVE STANDING TO SEEK RECONSIDERATION OR CLARIFICATION OF THE DEMS RELOCATION ORDER.

In the Joint Opposition, Teligent improperly relied on *SunCom Mobile & Data, Inc. v. FCC*[5] to argue that WinStar and the other Petitioners do not have standing to dispute the DEMS Relocation Order.[6] This case has no bearing on WinStar's standing because the instant proceeding is a rulemaking. *SunCom* did not concern a rulemaking, and simply is inapplicable to the ability of the Petitioners to seek reconsideration or

[4] WinStar Petition for Clarification at 1-2.
[5] 87 F.3d 1386 (D.C. Cir. 1996) (*SunCom*).
[6] Joint Opposition at 22.

clarification of the DEMS Relocation Order.

Teligent actually contends that to the extent the Petitioners do not hold 18 GHz DEMS licenses, they are "identical" to the petitioner in *SunCom* in that they lack standing to challenge the Order.[7] This position is dubious at best. In *SunCom*, the petitioner requested specific action, including rule waiver, by the FCC on a proposed, unlicensed system. In the instant matter, the FCC has actually initiated and completed a rulemaking, albeit brief and private, and changed its regulations regarding DEMS.[8] Clearly, any "interested party" may petition for reconsideration of this action pursuant to Section 1.429 of the FCC's rules.[9] Indeed, the FCC itself identified the petitions filed in this matter as "Petitions for Reconsideration and Clarification of Action in Rulemaking Proceedings" and published these petitions pursuant to Section 1.429(e).[10] The FCC already has recognized WinStar as a petitioner under Section 1.429; the standing issue thus is moot.[11]

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[7] Id. at 23. However, as set forth in greater detail below, WinStar continues to assert that it has an interest in an 18 GHz DEMS license.

[8] See Appendix A: Final Rules to DEMS Relocation Order (six pages of text amending Parts 1, 2, and 101 of Title 47 of the Code of Federal Regulations).

[9] 47 C.F.R. § 1.429 (1996).

[10] See Exhibit I, Public Notice, Report No. 2205 (June 19, 1997) (underline added).

[11] In the unlikely event the Commission determines that the DEMS relocation order is not a rulemaking matter, millimeter wave band licensees, like WinStar, still have standing. The appropriate legal standard in that instance is set forth in Section 405(a) of the Communications Act of 1934, as amended, which allows a party to any proceeding before the Commission "or any other person aggrieved or whose interest are adversely affected thereby" to petition for reconsideration an order, decision, report or action that has been made or taken by the Commission. 47 U.S.C. § 405(a). See also 47 C.F.R. § 1.106(b)(1). Relying upon the Supreme Court's decision in *FCC v. Sanders Bros. Radio Station*, 309 U.S. 470, 477 (1940), the Commission has consistently and repeatedly held that an existing licensee is adversely affected by the grant of a license to a competitor and, as a result, has standing to challenge the Commission's action. See, e.g., *Knox Broadcasting, Inc.*, 1997 FCC LEXIS 1265, at ¶ 4 (1997); *Robert Louis Thompson*, 10 F.C.C.R. 11555 (Mass Media Bur. 1995); *American Mobilphone, Inc.*, 10 F.C.C.R. 12297, at ¶ 8 (Wireless Telecom. Bur. 1995).

In the Joint Opposition, Teligent falsely suggests that WinStar has made an improper claim that it has an interest in an 18 GHz DEMS license in order to establish standing in this case. WinStar strongly rejects Teligent's inaccurate accusation. As demonstrated above, WinStar does not need to "claim" it has an 18 GHz DEMS license to establish an interest in this proceeding. Moreover, and notwithstanding the assertions of Teligent, WinStar can fully document its 18 GHz license interest.

In its Petition for Clarification, WinStar noted that in late 1996 it purchased Local Area Telecommunications, Inc. ("LOCATE"), which held numerous FCC licenses. As a result of this transaction, WinStar acquired a number of DEMS authorizations, including an interest in one 18 GHz DEMS site in Atlanta, Georgia, call sign WHD 251. For the Commission's review, included in Exhibit II are copies of (1) call sign WHD 251, which is in fact also the identifier of a 10 GHz DEMS license in Atlanta, (2) a renewal notice for call sign WHD 251, and (3) a report regarding the Atlanta 18 GHz DEMS market that is derived from two sources: Interactive Systems, Inc. (the FCC's official database contractor) and FCC paper records (formerly Part 21 data) obtained by International

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While most of the decisions applying *Sanders* have involved the issuance of broadcast licenses, the Commission has applied these same principals in the non-broadcast context. See *American Mobilphone*, 10 F.C.C.R. 12297 (competitor licensee in affected service areas had standing to challenge assignment of license in Paging and Radiotelephone Service). Moreover, to have standing, a licensee need not be authorized in the same band or service as the party whose license grant it is challenging. See *Rivoli Realty*, 27 F.C.C.2d 1004 (1971) (licensee of FM radio station could seek reconsideration of Commission's grant of construction permit for new UHF television broadcast translator stations). Clearly, if a licensee can be adversely affected by the grant of a license to another party in a particular market, it certainly stands to suffer economic harm where, as here, the Commission substantially increased Teligent's bandwidth in numerous areas throughout the country. Other millimeter wave licensees, such as WinStar, operate in many of the areas in which Teligent is licensed. Each one of these licensees thus has standing to petition the DEMS Relocation Order even in the unlikely event that this matter is somehow not deemed a rulemaking.

Transcription Services (the FCC's official copying agent). Due to the results of a recently completed internal audit of the license, WinStar initiated the necessary steps to complete construction of the underlying facility. It has since filed with the Commission a request for waiver and a notice of equipment change. WinStar is hopeful that this filing will be approved in light of the favorable treatment that already has been afforded to a number of other 18 GHz DEMS licensees directly associated with Teligent.

In summary, though, WinStar believes that it presently does have an 18 GHz DEMS interest, and, in this regard, it reaffirms the positions set forth in its Petition for Clarification. Specifically, WinStar requests that the Commission clarify (1) the scope of permissible communications at 24 GHz DEMS in light of the fourfold increase in spectrum, (2) the construction requirements at 24 GHz, and (3) the reimbursement and relocation procedures for the move from 18 GHz to 24 GHz.

II. THE FOURFOLD SPECTRUM INCREASE IN MOVING FROM 18 GHZ TO 24 GHZ IS UNSUPPORTED BY THE RECORD AND BASED ON QUESTIONABLE ASSUMPTIONS.

The decision to quadruple the amount of spectrum licensed to WinStar and other 18 GHz DEMS licensees is completely unsupported by the record in this matter. In its Petition for Clarification, WinStar noted that its "engineering assessments conclude that [the fourfold] increase in spectrum was unnecessary for traditional DEMS operations." Teligent, however, continues to maintain that the cryptic one-page analysis provided by

the Commission is a well-reasoned examination of the spectrum issue.[12] This simply is not the case. The analysis set forth in Appendix B (DEMS Relocation Technical Description) to the DEMS Relocation Order contains a number of assumptions that are not shared by the engineering community. Issues of spectrum allocation, especially involving a fourfold increase in bandwidth, must be addressed in a public forum where all interested parties can provide the Commission with a complete record.

Hatfield Associates, Inc. ("Hatfield") has performed an assessment, a copy of which is attached hereto as Exhibit III, of the technical documentation in support of the DEMS Relocation Order. To summarize, the Hatfield Technical Assessment calls into question a number of assumptions made in the DEMS Relocation Order. These assumptions, when taken together, significantly undermine the credibility of the public record support for the Commission's decision to award the 18 GHz DEMS licensees 400 MHz of spectrum at 24 GHz. One of the key assumptions is that existing licensees will not be able to increase their transmitter power when relocating to the 24 GHz band. This assumption is in turn based on two other assumptions made by the Commission: (1) that it is necessary to use the same type of equipment in use today to transition to 24 GHz as quickly as possible,[13] and (2) that the existing equipment is being used at the limits of its technical characteristics. Other important assumptions identified by Hatfield that underlie the Commission's analysis include: (1) a typical cell radius of 5 km for existing 18 GHz

[12] Joint Opposition at 28-29. "In accordance with fundamental engineering principles, the Commission appropriately considered the following technical and public policy factors in connection with the DEMS relocation."

systems, (2) a desired path reliability of 99.99 percent, and (3) a typical offered traffic load of .2 Erlang per subscriber or line in the busy hour.

Hatfield proceeds to challenge each of the assumptions set forth in the Commission analysis based on fundamental engineering principles. For example, the Technical Assessment severely questions the assumption that relocated DEMS licensees will be unable to increase transmitter power at 24 GHz. Considering Shannon's laws and other well-established engineering principles, any decrease in capacity caused by the relocation to 24 GHz can in fact be compensated by an increase in transmitter power. Yet, the Commission has ignored the concept of higher-powered equipment in favor of a fourfold increase in spectrum. This decision runs directly counter to the Commission's current predilection to designate all commercial spectrum for auction. In the matter at issue herein, which involves the allocation of 400 MHz of commercial spectrum, it is difficult to believe that the Commission failed to provide any economic analysis in support of its virtually unprecedented decision. "In other words, an increase in transmitter power could produce hundreds of millions – if not billions – of dollars worth of spectrum savings compared with the remedies chosen by the Commission."[14]

Finally, Hatfield presents a series of conclusions that vividly challenge the decision to quadruple at 24 GHz the amount of spectrum presently allocated to 18 GHz DEMS licensees:

[13] The assumption of exigency is especially dubious in light of the FCC's decision to allow all DEMS licenses in the 18 GHz band (except those in the area of Washington, D.C. and Denver) until January 1, 2001 to transition to 24 GHz.

(1) "[T]he Commission's technical analysis is not plausible if the underlying assumptions are not sound. We have serious reservations about the underlying assumptions. However, because of the lack of any accompanying narrative with even a modest amount of detail, we were unable to verify the Commission's calculations with any degree of certainty."[15]

(2) "[M]any of the assumptions the Commission made are devoid of any supporting rationale. This is particularly important because small differences in some of these assumptions can make a drastic difference in the amount of additional spectrum required."[16]

(3) "[R]elaxing some of the constraints inherent in the Commission's assumptions could result in substantial savings in the amount of spectrum required to compensate for any additional signal attenuation in the 24 GHz band."[17]

Most importantly and based on the above conclusions, Hatfield ultimately reasons that if the Commission does open up the DEMS Relocation Order for reconsideration, "then we believe it is highly likely that the amount of additional spectrum that the Commission allocated to the DEMS in the 24 GHz band will ultimately be judged to be substantially larger than can be justified on public policy grounds."[18]

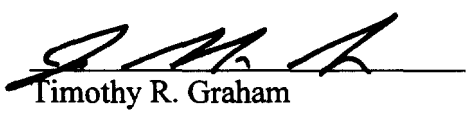
WinStar urges the Commission to re-open this matter so that the engineering community, including such experts as Hatfield Associates, Inc. can be heard. The Commission cannot ignore such a compelling engineering report when allocating 400 MHz of commercial spectrum – one of its single, largest spectrum allocations to date.

[14] Technical Assessment at 5.
[15] Id. at 8.
[16] Id.
[17] Id.
[18] Id. at 9.

WHEREFORE, THE PREMISES CONSIDERED, WinStar Communications, Inc. requests that the Commission proceed in this matter consistent with the positions set forth above.

Respectfully submitted,

WinStar Communications, Inc.



Timothy R. Graham
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Washington, D.C. 20036
202-833-5678

Date: July 23, 1997

EXHIBIT I

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PUBLIC NOTICE

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Federal Communications Commission
1919 M St., N.W.
Washington, D.C. 20554

News media information 202 / 418-0500
Fax-On-Demand 202 / 418-2830
Internet: http://www.fcc.gov
ftp.fcc.gov

Report No. 2205 June 19, 1997

PETITIONS FOR RECONSIDERATION AND CLARIFICATION OF ACTION IN RULEMAKING PROCEEDINGS

Petitions for reconsideration have been filed in the Commission's rulemaking proceedings listed in this Public Notice and published purusant to 47 CFR Section 1.429(e). The full text of these documents are available for viewing and copying in Room 239, 1919 M Street, N.W., Washington, D.C. or may be purchase from the Commission's copy contractor, ITS, Inc. (202) 857-3800. Oppositions to these petitions must be filed within 15 days of the date of public notice of the petitions in the Federal Register. See Section 1.4(b)(1) of the Commission's rule (47 CFR 1.4.(b)(1). Replies to an opposition must be filed within 10 days after the time for filing oppositions has expired.

SUBJECT: Amendment of the Commission's Rules to Relocate the Digital Electronic Message Service from the 18 GHz Band to the 24 GHz Band and to Allocate the 24GHz Band for Fixed Service. (ET Docket No. 97-99)

FILED BY: Richard E. Wiley, R. Michael Senkowski and Eric W. DeSilva, Attorneys for Millimeter Wave Carrier Association, Inc. on 06-05-97.
Timothy R. Graham, Leo I. George, Joseph M. Sandri, Jr. and Barry J. Ohlson, Attorneys for WinStar Communications, Inc. on 06-05-97.
David G. Frolio and David G. Richards, Attorneys for BellSouth Corporation on 06-06-97.
Gary M. Epstein, John P. Janka, James H. Baker and Nandan M. Joshi, Attorneys for DirectTV Enterprises, Inc. on 06-05-97.
Glenn B. Manishin, Frank V. Paganelli and Stephanie A. Joyce, Attorneys for WebCel Communications, Inc. on 06-05-97.

EXHIBIT II

GA FULTON FEDERAL COMMUNICATIONS COMMISSION

RADIO STATION AUTHORIZATION

CONSTRUCTION PERMIT

462-B SEPTEMBER 1975

PERMITTEE LOCAL AREA TELECOMMUNICATIONS, INC.

17 BATTERY PLACE
NEW YORK, NY 10004

COMMON CARRIER DIGITAL ELECTRONIC MESSAGE SERVICE

SUBJECT TO THE PROVISIONS OF THE COMMUNICATIONS ACT OF 1934, SUBSEQUENT ACTS, TREATIES, AND ALL REGULATIONS HERETOFORE OR HEREAFTER MADE THEREUNDER, AND FURTHER SUBJECT TO THE CONDITIONS SET FORTH IN THIS PERMIT, INCLUDING THOSE CONTAINED ON THE REVERSE HEREOF, AUTHORITY IS HEREBY GRANTED TO CONSTRUCT RADIO FACILITIES TO BE OPERATED AS HEREINAFTER DESCRIBED:

FILE NO. 32-CDM-P -84 CALL SIGN WHD251
STATION C.P. EXPIRATION DATE - FEB 17, 1989
GRANT DATE - MAY 29, 1987
NETWORK COMPLETION DATE - FEB 17, 1989

STATION LOCATION - 2 PEACHTRE STREET NW - ATLANTA 2 - (FULTON)GA SERVICE AREA -ATLANTA GA

LATITUDE 33 45 21 N. - LONGITUDE 084 23 27 W. CONTROL POINT - LOCAL

GROUND ELEVATION 1045 FT. STRUCTURE HEIGHT 549 FT. ABOVE GROUND BUILDING HEIGHT 544 FT. TOTAL HEIGHT 1594 FT. AMSL
ANTENNA HEIGHT 549 FT. A.G.L.

18900.0 - 18910.0 MHZ (04) ERICSSON CFR8DMUL184522 500.0 MW 2500F9Y EMISSION DESIGNATOR

HOT-STANDBY TRANSMITTER AUTHORIZED IS ERICSSON CFR8DMUL184522
NUMBER OF SUBSCRIBER UNITS AUTHORIZED 20

ANTENNA MANUFACTURER AND TYPE - ERICSSON UKY21002/1 DB LINE LOSS FROM TRANSMITTER TO ANTENNA

FCC FORM 715-OBSTRUCTION MARKINGS REQUIRED IN ACCORDANCE WITH PARAGRAPHS MARKING NOT REQUIRED

BY ITS FAILURE TO RETURN THE ATTACHED CONSTRUCTION PERMIT WITHIN 30 DAYS OF THE DATE OF THE CONSTRUCTION PERMIT, THE GRANTEE OF THE PERMIT IS AGREEING TO THE FOLLOWING CONDITION(S):

PERMITTEE IS REQUIRED TO FILE WITH FCC, DATA INDICATING THE CENTER CARRIER FREQUENCIES TO BE TRANSMITTED WITHIN ITS ASSIGNED CHANNEL, THE POLARIZATION OF EACH NODAL TRANSMITTING ANTENNA, AND THE AZIMUTH OF THE MAIN LOBE FOR EACH NODAL TRANSMITTING ANTENNA. UNLESS REQUESTED EARLIER FOR FREQUENCY INTERFERENCE ANALYSES, THIS DATA MUST BE INCORPORATED IN THE FILING OF THE LICENSE APPLICATION (FORM 436), UPON COMPLETION OF CONSTRUCTION.

LV 870826

FEDERAL COMMUNICATIONS COMMISSION

UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION

RADIO STATION AUTHORIZATION

GA

RENEWAL OF LICENSE

LICENSEE: LOCAL AREA TELECOMMUNICATIONS, INC.
17 BATTERY PLACE
SUITE 1200
NEW YORK, NY 10004-1256

COMMON CARRIER DIGITAL ELECTRONIC MESSAGE SERVICE

SUBJECT TO THE PROVISIONS OF THE COMMUNICATIONS ACT OF 1934, SUBSEQUENT ACTS, TREATIES, AND ALL REGULATIONS HERETOFORE OR HEREAFTER MADE THEREUNDER, AND FURTHER SUBJECT TO THE CONDITIONS SET FORTH IN THIS LICENSE, INCLUDING THOSE CONTAINED ON THE REVERSE HEREOF, AUTHORITY IS HEREBY GRANTED TO USE AND OPERATE THE RADIO FACILITIES HEREINAFTER DESCRIBED:

FILE NO. 28091-CE-R-91 CALL SIGN - WHD251
LICENSE EXPIRATION DATE - Feb 01, 2001
GRANT DATE - Apr 17, 1991

STATION LOCATION - - ATLANTA - () GA SERVICE AREA - ATLANTA GA

LATITUDE N. - LONGITUDE W. CONTROL POINT - LOCAL

GROUND ELEVATION FT. STRUCTURE HEIGHT FT. ABOVE GROUND BUILDING HEIGHT FT. TOTAL HEIGHT FT. AMSL

ANTENNA HEIGHT FT. A.G.L.

MHZ ( ) MW EMISSION DESIGNATOR

NUMBER OF SUBSCRIBER UNITS AUTHORIZED

ANTENNA MANUFACTURER AND TYPE -

FCC FORM 715-OBSTRUCTION MARKING IS NOT REQUIRED.

8600145 12/03/1991

(Atlanta, GA)

Frequency	Licensee	Callsign	File Number	Exp Dt	Cls	Units	S
Channel 25 (18820-18830 MHz)							
(Vacant)							
Channel 26 (18830-18840 MHz)							
18835.00000	MOTOROLA INC	WNTE373	780757	970421	FXO		G
Channel 27 (18840-18850 MHz)							
18845.00000	MOTOROLA INC	WNTM765	780738	970421	FXO		G
18845.00000	MOTOROLA INC	WNTH352	9511721779	010119	FXO	1	G
18845.00000	SATCOM COMMUNICATIONS, I	WNEE592	754351	950228	FXO		G
Channel 28 (18850-18860 MHz)							
18855.00000	BESMAN INC	WNTG343	9508718881	001017	FXO	1	G
Channel 29 (18860-18870 MHz)							
18865.00000	MOTOROLA INC	WNTF381	792748	980712	FXO		G
18865.00000	MOTOROLA INC	WNTG509	762701	950926	FXO		G
Channel 30 (18870-18880 MHz)							
18870.00000	ASSOCIATED MDS CORPORATI	WHT823	48-CE-MP/L 90	910126	DEMS	1	E
18870.00000	MICROWAVE SERVICES, INC.	WMT335	1787-CE-P/L-94		DEMS		
Channel 31 (18880-18890 MHz)							
18880.00000	DIGITAL SERVICES CORPORA	WMT317	16-CE-P/L-94				
Channel 32 (18890-18900 MHz)							
18890.00000	MICROWAVE SERVICES, INC.	WMT335	1787-CE-P/L-94		DEMS		
Channel 33 (18900-18910 MHz)							
18900.00000	MICROWAVE SERVICES, INC.	WMT335	1787-CE-P/L-94		DEMS		
18900.00000	LOCAL AREA TELECOM	WHD251	28091-CE-R-91	010201	DEMS	1	G
Channel 34 (18910-18920 MHz)							
18910.00000	MICROWAVE SERVICES, INC.	WMT335	1787-CE-P/L-94		DEMS		

This exhibit was prepared from two sources: the FCC's third-party database provider, Interactive Systems, Inc. (ISI) (formerly Part 94 data) and from copies of FCC paper records retrieved by International Transcription Services, Inc. (ITS) (formerly Part 21 data).

EXHIBIT III

Technical Assessment of a Recent Federal Communications Commission Decision Relating to the Relocation of the Digital Electronic Message Service from the 18 GHz Band to the 24 GHz Band

Prepared by

Gene G. Ax
Dale N. Hatfield

of

Hatfield Associates, Inc.
737 29th Street, Suite 200
Boulder, Colorado 80303
Tel.: 303-442-5395
Fax: 303-442-9125

July 21, 1997

I. Introduction

On March 14, 1997, the Federal Communications Commission ("FCC" or "the Commission") released an Order in ET Docket No. 97-99.[1] In its *DEMS Order*, the Commission relocated the DEMS allocation from 18 GHz to 24 GHz and increased the amount of spectrum available to the relocated DEMS operators from 100 to 400 MHz. The Commission justified this fourfold increase in the amount of spectrum allocated to DEMS operators on technical grounds. Namely, they alleged that the additional spectrum was required to compensate for additional radio wave attenuation that the relocated operators would experience in the 24 GHz band. Following the release of the *DEMS Order*, the Commission released certain underlying technical documents relating to its decision.[2] The need for the additional spectrum has been a matter of intense dispute since the release of the *DEMS Order*.

Following the release of the *DEMS Order*, WinStar Communications, Inc. retained Hatfield Associates, Inc. ("HAI") to perform an independent technical assessment of the decision and the supporting technical documentation that the FCC publicly released on June 3, 1997 ("*Documentation*"). The remainder of this report, which contains the results of that assessment, is divided into four sections. Section II provides basic technical background for the issues at hand. Section III contains our assessment of the technical justification provided by the Commission for its decision, while Section IV contains a summary and statement of our conclusions. Finally, Section V provides information on the qualifications of HAI to conduct this assessment.

II. Background

A well-known principle in communications engineering, known formally as Shannon's Law, states that the maximum amount of information that can be conveyed per unit of time depends upon the bandwidth of the communications channel and the strength of the received signal compared to the strength of competing noise and interference. This means that the amount of information that can be conveyed per unit of time (i.e., the number of binary digits -- bits -- that can be transmitted per second in a digital system) increases with increasing bandwidth and/or increased received signal power relative to noise and interference. Thus, if the ratio between the desired signal and the noise/interference remains constant, the amount of information that can be conveyed increases linearly with bandwidth. That is, for a constant signal-to-noise/interference

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[1] *Amendment of the Commission's Rules to Relocate the Digital Electronic Message Service From the 18 GHz Band to the 24 GHz Band and to Allocate the 24 GHz Band For Fixed Service*, Order, ET Docket No. 97-99, FCC 97-95, 12 FCC Rcd 3471 (released March 14, 1997) ("*DEMS Order*").

[2] *See* Memorandum from Chris Murphy, Attorney-Advisor, International Bureau to William F. Canon, Acting Secretary of the Federal Communications Commission, June 3, 1997.

ratio, going from 100 MHz of bandwidth[3] to 400 MHz of bandwidth would increase the capacity available to a DEMS licensee by a factor of four.

In a radio system, as the radio wave propagates outward from the antenna, the signal spreads out and, consequently, gets weaker with distance. This natural weakening of the signal with distance is called the free space loss and it increases as the frequency increases.[4] At the microwave radio frequencies involved in the *DEMS Order*, the signal is also weakened (or, in more precise engineering terms, attenuated) by the presence of rainfall along the path between the transmitting and receiving antennas.[5] This additional loss also increases with increasing frequency.

Thus, in moving from 18 GHz to 24 GHz, the free space loss increases. However, in moving to higher frequencies, antennas become more effective. This means, for example, that a "dish" antenna with a diameter of one foot is more directive and has higher gain at the higher frequency than at the lower frequency. As it turns out, this increase in directivity or "antenna gain" with frequency (e.g., at the subscriber's location) exactly compensates for the increased free space loss in moving from 18 GHz to 24 GHz. As noted immediately above, the additional attenuation produced when rainfall is present along the path also increases with frequency. At 24 GHz, this added attenuation (compared to 18 GHz) decreases the received signal strength relative to the noise/interference. Because of Shannon's Law, this means that the capacity of the available bandwidth is reduced accordingly. Note, however, that the capacity can be restored by simply increasing the transmitter power and/or by increasing the gain (size) of the transmitting/receiving antennas. As discussed in more detail below, in its analysis, the Commission has chosen, instead, to compensate for this loss of capacity by simply giving the relocated DEMS operators substantially more spectrum in the 24 GHz band. Whether additional spectrum should be provided to the relocated DEMS operators in view of these other options and, if so, how much additional spectrum should be provided, is currently the subject of the dispute that is addressed in this report.

Before turning to our assessment of the Commission's decision, it may be useful to address four additional technical factors. First, it is assumed that the DEMS licensees operate their systems in a cellular configuration. That is, hubs or base stations are strategically distributed over a geographic area in order (a) to provide coverage over a large (e.g., metropolitan) area, (b) to allow the same frequencies to be reused multiple times within that geographic area, and (c) to reduce the cost of subscriber equipment by keeping, for example, power and antenna

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[3]The 20 MHz of bandwidth per channel in the 18 GHz band was increased to 80 MHz per channel in the 24 GHz band.

[4]Speaking more precisely, the free space loss is defined technically as the loss between two non-directional or "isotropic" antennas.

[5]Other losses are involved, but they are relatively small compared to the rain attenuation.

requirements modest. If user or subscriber demand is relatively low, the operator has the incentive to make the coverage of each cell as large as possible to reduce the number of cell sites required, and thereby minimize the required infrastructure investment. Systems operated under these conditions are said to be coverage limited. On the other hand, if demand is relatively high, the operator has the incentive to increase the number of cell sites while decreasing the coverage of each in order to achieve increased capacity through frequency reuse. This distinction is important in the assessment which follows. It is important because, if the system is capacity limited, the typical coverage radius of each cell will be less, perhaps much less, than the characteristics of the system (e.g., maximum transmitter power) would otherwise allow. If this is the case, moving up in frequency (i.e., from 18 GHz to 24 GHz) would carry no penalty since the increased rain attenuation could be compensated for by, for example, an increase in power that is readily within the constraints imposed by the characteristics of the equipment.

Second, in certain applications (e.g., wireless local loops), customer traffic (e.g., ordinary telephone calls) may be intermittent and of relatively short duration. If the traffic generated by customers has this characteristic, it is inefficient to permanently assign a radio channel out of the available spectrum to each customer. Rather, it is more efficient to pool the channels and assign channels from the pool to a customer on a dynamic, as-needed basis. If the amount of traffic generated by each customer is relatively light, dynamic channel assignment (or trunking as it is often referred to) can significantly increase the amount of traffic that can be carried on a given set of channels (i.e., in a given amount of spectrum). On the other hand, if the amount of traffic generated by each customer is very heavy, the potential increase in traffic handling capacity due to dynamic channel assignment is correspondingly less. In the limit, if a particular customer wants a permanent connection to the network (e.g., a dedicated line or dedicated access), then dynamic channel assignment/trunking provides no improvement in efficiency whatsoever.[6] This difference in the benefits of dynamic channel assignment is also important in the assessment which follows.

Third, in the DEMS system, radio frequency ("RF") amplifiers are used at the subscriber's location to boost transmitted signal power. If these output amplifiers are used to amplify more than a single radio signal or carrier, then the power of the transmitter must be reduced for some technical reasons. This is referred to as "output power backoff." This reduction in transmitter power translates into a reduction in the received signal strength at the customer's location. Conversely, going from multiple channels to a single channel allows the transmitter power (and hence received signal strength) to be increased. This characteristic of transmitters is also important in the assessment which follows.

Fourth, and finally, if the level of the received signal is very strong relative to the noise/interference, then very subtle differences in the characteristics of the desired signal can be used to convey information. This means that at high signal-to-noise/interference ratios, more information can be conveyed per unit of time in a given amount of bandwidth than at low signal-

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[6]There are other techniques for dynamically allocating the available bandwidth, but the notion of trunking is used here for simplicity of understanding.

to-noise/interference ratios. Increasing the rate at which information is conveyed at higher signal-to-noise/interference ratios is accomplished by using what is referred to as higher level modulation.[7] At lower signal to noise/interference ratios, less subtle differences in the characteristic of the desired signal must be used to convey information because more subtle changes would be masked by the presence of the noise and/or interference. This means that at low signal to noise/interference ratios, less information can be conveyed per unit of time in a given amount of bandwidth. Note that what is being expressed here is simply the result of the application of Shannon's Law. That is, for a given amount of bandwidth, more information can be conveyed per unit of time if the received signal-to-noise/interference ratio is higher. This notion is also important in the assessment which follows.

III. Assessment

1. Analysis of the "Base" Case

In Appendix B of its *DEMS Order*, the Commission provided a brief (less than one full page) and very cryptic description of the technical analysis that led it to conclude that the changes in system operation necessary to compensate for the greater losses at 24 GHz compared to 18 GHz result in a loss in system capacity in excess of four times the capacity at 18 GHz. This result is based upon certain key assumptions which we will refer to as comprising the base case. One key assumption is that existing licensees will not be able to increase their transmitter power when relocating to the 24 GHz band. Note that this assumption, in turn, appears to rely upon two other assumptions -- first that it is necessary to use the same type of equipment that is in use today in order to make the transition to 24 GHz as rapidly as possible,[8] and second, that the existing equipment is being used at the limits of its technical characteristics (e.g., in terms of transmitter power). Other key assumptions underlying the Commission's analysis include (1) a typical cell radius of 5 km for existing 18 GHz systems, (2) a desired path reliability of 99.99 percent, and (3) a typical offered traffic load of .2 Erlang per subscriber or line in the busy-hour.[9] All of these assumptions play a major role in the determination of the amount of increased channel bandwidth needed, if any, to compensate for the greater losses at 24 GHz.

As we have stated before, the Commission's description of its technical analysis is brief and very cryptic. Moreover, to the best of our knowledge, it has not released a narrative

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[7]Modulation is simply the process of varying one or more characteristics of a radio signal or wave (e.g., its amplitude and/or phase) in accordance with an information bearing signal.

[8]Estimated costs and time delays necessary to justify this assumption were not provided in the *DEMS Order*. However, as a general rule, the cost of radio equipment, and its efficiency and effectiveness, has improved and continues to improve rapidly.

[9]An Erlang is a measure of traffic intensity. One Erlang is equivalent to a line that is in use 100 percent of the time.

description that sets forth its assumptions and calculations as they relate to the supporting materials contained in the *Documentation*. Hence, it has not been possible to verify whether the Commission ever conducted an analysis; and if the analysis occurred, whether it was valid. Nevertheless, based upon a review of the limited materials that have been made publicly available, we conclude that the results of the analysis are plausible only if the underlying assumptions are sound. However, for reasons discussed in more detail below, we have serious reservations about many of those underlying assumptions.

2. Analysis of the Underlying Assumptions

a. Equipment constraints

As noted above, one of the key assumptions underlying the Commission's analysis is that DEMS operators relocating to the 24 GHz band will not be able to increase the transmitter power of their equipment. However, based upon Shannon's Law and associated communications engineering principles, we know that any decreases in capacity produced by the added losses at 24 GHz can be exactly compensated for by an increase in transmitter power. Furthermore, based upon our knowledge of the state-of-the-art in microwave equipment design, there is no reason that the power cannot be increased with new equipment, thus avoiding the need to compensate for the losses by increasing the amount of spectrum given to existing 18 GHz operators making the transition. Although the focus of this analysis is on technical rather than economic issues, we feel compelled to point out that, based upon expected spectrum auction results, the value of the spectrum saved could be enormous. More fundamentally, the Commission provides no supporting economic analysis that examines the cost of increasing transmitter power versus the opportunity cost associated with giving the additional spectrum to existing licensees. In other words, an increase in transmitter power could produce hundreds of millions -- if not billions -- of dollars worth of spectrum savings compared with the remedies chosen by the Commission.

b. Typical cell radius at 18 GHz

Another key assumption underlying the Commission's analysis is that the typical cell at 18 GHz has a radius of 5 km. Due to the limited construction and deployment of 18 GHz DEMS systems, and the concomitant lack of significant traffic patterns and frequency reuse, there are no apparent field data in the publicly available record proving the validity of this assumption. The *Documentation* suggests that, due to the added losses associated with moving up in frequency, the radius of coverage would be reduced to about 3.75 km assuming no other changes in equipment characteristics. Note, however, that if the typical cell radius of coverage at 18 GHz were really 3.75 km rather than 5 km, <u>then no additional spectrum would be required</u> to provide comparable coverage and capacity. As we pointed out earlier, a licensee may reduce cell sizes below that permitted by the equipment for a number of reasons including to achieve an increase in

the amount of frequency reuse.[10] Furthermore, the licensee may have to reduce the radius of coverage in order to maintain line-of-sight paths to subscribers -- especially in heavily urbanized areas.

To repeat, if typical cell radius of coverage at 18 GHz is less than the 5 km assumed by the Commission due to either of these two factors, then the amount of added spectrum needed to compensate for the added losses is reduced accordingly. In the Appendix, we have provided engineering calculations that further demonstrate that the amount of additional spectrum that is required to compensate for the added losses in moving to 24 GHz is highly dependent upon the assumption regarding the typical cell radius of coverage at 18 GHz. Despite the importance of this assumption, we were unable to locate in the *DEMS Order*, nor in the *Documents*, any support whatsoever for the supposition that the typical radius of coverage of DEMS systems operating at 18 GHz is, in fact, 5 km. Indeed, it appears that the Commission merely assumed the typical cell radius was the same as the maximum cell radius permitted by the currently available equipment.

c. Path reliability

Because of the normal statistical fluctuations in received signal strength due to rainfall and other effects, microwave paths are usually designed to achieve a particular level of reliability or availability. A change in the assumed path reliability or availability can have a rather dramatic impact on the level of rain attenuation that must be overcome. In general, lower levels of assumed reliability or availability reduce the differences between frequency bands. For example, the Commission computes the additional path loss at 24 GHz due to rain attenuation as 9.5 dB based upon an assumed path reliability of 99.99 percent. Document 1 of the *Documentation*, however, provides a similar analysis based upon a criterion of a 99.7 percent availability.[11] Under the criterion of a reliability of 99.7 percent, this document states the following in comparing the viability of the 18 and 24 GHz bands:

> In summary, the only potentially significant issue is propagation losses. For worst case conditions they could be almost 6 dB higher in the 24 GHz band compared to the 18 GHz band. For more typical conditions the difference is less than 2 dB. From a technical standpoint, relocating DEMS to the 24 GHz band results in a viable system. [Emphasis added.]

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[10]This point is illustrated by the operation of current cellular mobile radio systems. The equipment is capable of operating with cells with a coverage radius on the order of 12 miles or more. However, typical cell sizes are much smaller, especially in major metropolitan areas, because of the need to achieve greater capacity through frequency reuse.

[11]Memorandum from Mark A. Sturza to Russ Daggatt dated 05 December 1996 and attached to memorandum from Larry Williams to Steve Sharkey dated December 6, 1996; included as Document 1 in the *Documents*.

If one compares the Commission's 9.5 dB of rain attenuation for typical conditions with the 2 dB arrived at in the referenced document, it is easy to see the dramatic difference any assumptions for reliability can have on the end result. That is, the amount of additional spectrum required to compensate for the added path loss in moving from 18 GHz to 24 GHz is highly dependent upon the assumption regarding path reliability. Despite the importance of this assumption on the amount of spectrum required, no justification for the criterion chosen is provided in the Commission's *DEMS Order*.

d. Offered traffic load and output amplifier back off

In Section II, above, it was explained how traffic concentration through trunking can decrease the number of channels (and, hence limit the amount of spectrum) required to carry a given amount of traffic. It was also explained that the actual gain in efficiency is highly dependent upon the amount of traffic generated by each customer. If the amount of traffic generated by each subscriber is relatively light, the gains in trunking/spectrum efficiency are correspondingly greater. If, on the other hand, the amount of traffic generated by each subscriber is relatively heavy, the gains in trunking/spectrum efficiency are correspondingly less. The Commission and the *Documentation* refer to this technique as Dynamic Bandwidth Allocation ("DBA").

In its analysis, the Commission apparently assumes that, in order to overcome the added path loss at 24 GHz, the relocated operators will have to abandon the DBA mode of operation for some geographically more distant customers and, instead, shift them to dedicated channels. The latter is referred to as Fixed Bandwidth Allocation ("FBA"). This has two effects. On the one hand, it allows the transmitted power to be increased because output amplifier back off is not required with a single signal. According to the Commission, this amounts to a 4 dB increase in power. It is this increase in power that is used to recoup a portion of the increased losses associated with relocating to 24 GHz. On the other hand, the change to the FBA mode of operation reduces spectrum efficiency for the reasons stated earlier. This means that, under these assumptions, more spectrum must be provided to the relocated DEMS operators. From the materials contained in the *Documents* it appears that this change accounts for a substantial portion of the additional 300 MHz of spectrum.

This leads us to make two observations. First, simply increasing the transmitter power in the 24 GHz band by 4 dB would save a substantial amount of spectrum. Second, the amount of inefficiency that results from a shift from DBA to FBA depends upon the amount of traffic generated by each subscriber line. This is because, as explained above, DBA provides larger gains in efficiency when per subscriber usage is low and lower gains when it is high. Apparently, the Commission's analysis assumes each subscriber line generates .2 Erlangs of offered traffic during the busyhour. The material contained in the *Documentation* tends to demonstrate that this assumed traffic load can have a dramatic effect on spectrum efficiency and hence on the amount of spectrum required. Once again, despite the importance of this assumption, no justification for it is provided in the Commission's *DEMS Order*.

e. Modulation efficiency

To recoup the balance of the added losses associated with shifting to 24 GHz, the Commission assumes that the DEMS operators will have to go to lower level modulation techniques in order to provide coverage out toward the edges of a cell. This, of course, is in lieu of simply increasing the transmitter power as discussed before. As explained in Section II, the use of lower level modulation means that a given amount of bandwidth is used less efficiently. Hence, additional spectrum is required to offset the decrease in efficiency and this reduction in efficiency accounts for a large portion of the added bandwidth requirement. However, recall that lower level modulation techniques are more resistant to interference. This increased resistance to interference or "robustness" means that, with lower level modulation, the cells comprising a DEMS system can be located closer to each other, thus permitting increased frequency reuse in a given geographic area. This increased amount of frequency reuse would offset at least some of the loss of efficiency otherwise associated with shifting to lower level modulation. Despite this potential for an offsetting increase in capacity in shifting to the 24 GHz band, we were unable to locate any discussion of this factor in the Commission's *DEMS Order* or in the *Documentation*.

IV. Summary and Conclusions

Based upon our technical review of the Commission's *DEMS Order* and the *Documentation*, we have reached the following fundamental conclusions:

First, the Commission's technical analysis is not plausible if the underlying assumptions are not sound. We have serious reservations about the underlying assumptions. However, because of the lack of any accompanying narrative with even a modest amount of detail, we were unable to verify the Commission's calculations with any degree of certainty. This is especially true in terms of relating the material contained in the *Documentation* to the Commission's own analysis.

Second, many of the assumptions the Commission made are devoid of any supporting rationale. This is particularly important because small differences in some of these assumptions can make a drastic difference in the amount of additional spectrum required.

Third, relaxing some of the constraints inherent in the Commission's assumptions could result in substantial savings in the amount of spectrum required to compensate for any additional signal attenuation in the 24 GHz band. More generally, in radio systems of this type, there are complex tradeoffs between coverage, frequency reuse, capacity, transmitter power, antenna directivity/gain, modulation efficiency, path reliability, and error correction coding to name just a few. Because of the potential value of this spectrum and the profound effects of these various tradeoffs on the amount of spectrum required, sound public policy would appear to require a full exploration of these assumptions and their rationale.